

Poster presentation

Development and validation of a short 31P cardiac magnetic resonance spectroscopy protocolSairia Dass*¹, Lowri E Cochlin², Cameron J Holloway², Joseph J Suttie¹, Andrew W Johnson², Damian J Tyler², Hugh Watkins³, Matthew D Robson¹, Kieran Clarke² and Stefan Neubauer¹Address: ¹OCMR, Department of Cardiovascular Medicine, University of Oxford, UK, ²Department of Physiology, University of Oxford, UK and ³Department of Cardiovascular Medicine, University of Oxford, UK

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Introduction

Cardiac 31P-MRS is the only non-invasive in vivo technique for the determination of cardiac high energy phosphate metabolism. Changes in cardiac phosphocreatine to adenosine triphosphate ratios (PCr/ATP) occur in common cardiac pathologies and have diagnostic, prognostic and therapeutic utility. However, long acquisition times (20 minutes or more, depending on heart rate) required to achieve sufficient signal to noise ratios for reliable interpretation have limited the clinical utility of 31P-MRS studies in patients with severe cardiac disease.

We have developed an 8 minute 31P-MRS protocol and demonstrate the validity of this 'short' acquisition by comparison with a 'long' (at least 20 minutes) method of published reproducibility (Tyler, NMR Biomed:2008).

Purpose

To design a robust, 'short' cardiac 31P-magnetic resonance spectroscopy (31P-MRS) protocol which facilitates acquisition within a clinically acceptable timeframe.

Methods

Protocol development

This 'short' protocol essentially incorporates a larger voxel (93 mls compared to 39 mls for 'long' protocol) but eliminates extra myocardial contamination by:

- active suppression of chest wall muscle and liver signals,
- raw data acquisition weighted to reduce contamination arising from outside the nominal voxel.

The accuracy of the data and its interpretation is improved by:

- optimised radio frequency (RF) pulse,
- flip angle calibration (at voxel of interest) used during post-processing to calculate and correct for subject variation to coil loading.
- calibrated signal enhancement (Nuclear Overhauser Enhancement (NOE)),
- rapid repetition time (with calibrated saturation correction).

Validity

22 healthy volunteers (age 42 ± 16.5 ; 13 males, 9 females), were scanned (3 T Siemens Trio) with both the 'long' and 'short' acquisitions.

Acquisition parameters for both protocols are summarised and compared in Table 1.

Table 1: Selected acquisition properties of compred protocols

| | Control (long, 20 min) protocol | Short (8 min) protocol |
|---|---------------------------------|------------------------|
| 3D CSI Matric size | 16 × 16 × 16 | 16 × 8 × 8 |
| Field of view | 240 × 240 × 240 mm | 240 × 240 × 240 mm |
| Voxel size | 29 mls | 93 mls |
| Cardiac gated | Yes | No, TR 720 ms |
| Acquisition time | >+ = 20 mins | 8 min |
| Chest wall muscle saturation | Yes | Yes |
| Liver saturation | No | Yes |
| NOE | Yes | Yes |
| RF saturation, NOE and blood correction factors applied | Yes | Yes |
| Subject specific flip angle map acquired | Yes | Yes |

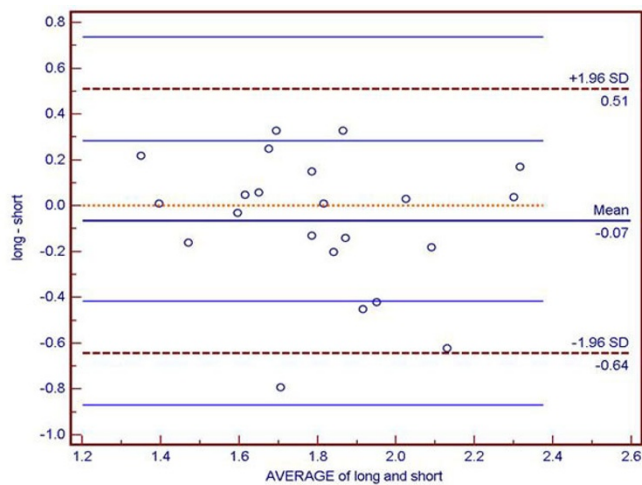


Figure 1
PCr/ATP ration derived from data acquired with the 'long' versus the 'short' 31P-MRS methods using a Bland Altman plot.

Results

There was no difference of derived PCr/ATP ratios for both methods ('short' 1.83 ± 0.32 ; 'long' 1.78 ± 0.27). Bland-Altman analysis demonstrates excellent agreement between the two methods (Figure 1) confirming equivalence for clinical purposes. Figure 2 shows an example of spectra acquired from one subject, using both methods.

Conclusion

We have developed a novel 'short' cardiac 31P-MRS protocol of high data quality. This protocol allows cardiac spectroscopy to be measured in patients who are often intolerant of long acquisition times, such as those with severe cardiac disease and children. Hence this work provides a useful tool for the routine clinical assessment of cardiac 31P-MRS.

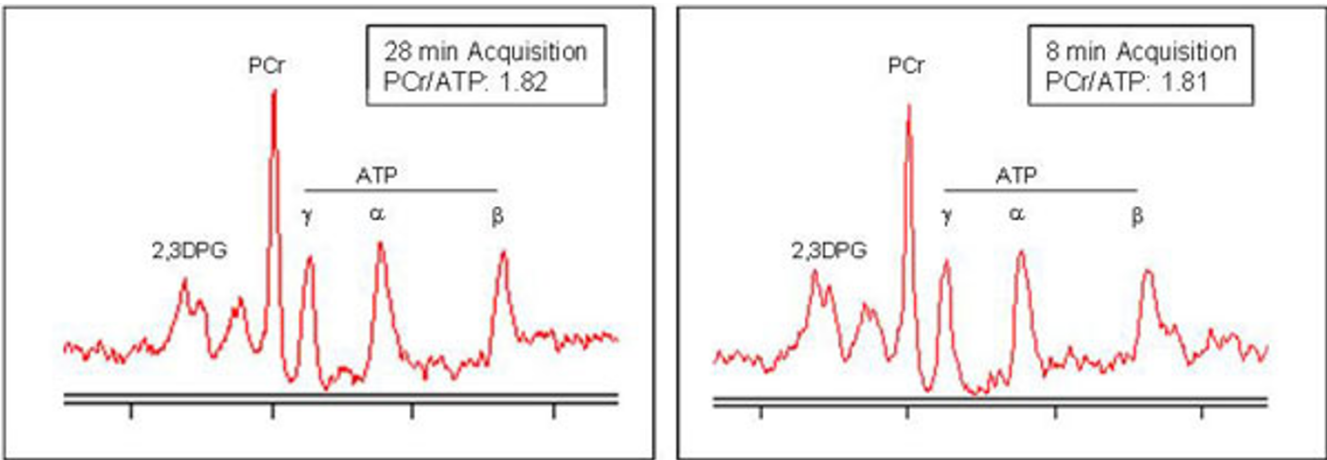


Figure 2
Comparing spectroscopy for one subject (heart rate 60), requiring 28 minutes for the 'long' control acquisition vs the new 'short' (8 minute) protocol. PCr (phosphocreatine); 2, 3 DPG (2, 3 diphosphoglycerate); ATP (adenosinetriphosphate) are indicated.